On Trajectory Generation for Flexible Space Crane: Inverse Dynamics Analysis by LATDYN

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Abstract

For future in-space construction facility, one or more space cranes capable of manipulating and positioning large and massive spacecraft components will be needed. Because the space systems being constructed are relatively large and massive, the space cranes must have a reach on the order of 100-meter and be made of truss-type construction for structural efficiency. In order to optimize space crane's performance, an operational strategy consisting of gross-motion and fine-motion phases was proposed. Under this strategy, a space crane is commanded into position in a relatively fast pre-planned trajectory with relaxed requirements, and then "rigidized" by bracing against either the workpiece or an auxiliary support structure. After bracing, the subsequent fine motion will not involve the major crane bodies, and the precision movements between the workpieces can be performed without the adverse flexible crane body effect.

Inverse dynamics has been extensively studied as a basis for trajectory generation and control of robot manipulators. This paper will focus on trajectory generation in the gross-motion phase of space crane operation. Inverse dynamics of the flexible crane body is much more complex and intricate as compared with a rigid robot link. To model and solve the space crane's inverse dynamics problem, LATDYN program which employs a three-dimensional finite element formulation for the multibody truss-type structures will be used. The formulation is oriented toward a joint dominated structure which is suitable for the proposed space crane concept. To track a planned

trajectory, procedures will be developed to obtain the actuation profile and dynamics envelope which are pertinent to the design and performance requirements of the space crane concept.